Declaration of Ross R. Sorci

I, Ross R. Sorci, hereby declare as follows:

1. I am Ross R. Sorci, Assistant Vice President, IIT Research Institute Center for Electromagnetic Science.

2. IITRI is a not-for-profit contract research organization serving both government and industry in a wide range of planning and engineering tasks related to the use of the electromagnetic spectrum. Since 1961, IITRI has been providing spectrum-related support to US Government agencies and the Department of Defense in the areas of spectrum planning and management, communications-electronics systems engineering, RF interference, electromagnetic compatibility, and the development and maintenance of supporting radio propagation and analysis computer models and databases. The Center for Electromagnetic Science (CEMS) was established in 1994 to leverage IITRI's experience and extensive range of computer models related to radio system engineering, and is now providing design, planning and engineering support to the commercial wireless community, as well as local and municipal governments.

I have over 20 years of telecommunications and RF systems engineering experience as a Division Manager and Project Manager. Specific areas of expertise include planning, conducting, and managing electromagnetic compatibility (EMC) and electromagnetic interference (EMI) analyses, radio system design, radio system performance evaluation, spectrum management, microwave link analysis, and computer modeling of communications and radar/ATC systems. I have also developed analysis techniques and design methodologies for high-capacity digital point-to-point systems, conducted radio communications site surveys, and generated test plans.

3. I prepared the accompanying Engineering Statement at the request of the ABC Television Affiliates Association, CBS Television Network Affiliates Association, Fox Television Affiliates Association, and NBC Television Affiliates Association (the "Network Affiliates") for use by the Network Affiliates in Reply Comments filed in response to the *Notice of Proposed Rule Making*, FCC 00-17, released January 20, 2000, in the matter of Establishment of an Improved Model for Predicting the Broadcast Television Field Strength at Individual Locations.

4. I was assisted in the preparation of the Engineering Statement by Paul A. Petsu. Mr. Petsu is an IITRI Science Adviser with over 31 years of experience performing analyses of RF systems including communications and radar systems, spread spectrum systems, satellites, and digital wireless systems. In addition, he has expertise in computer modeling and simulation, evaluation and application of standards, and electromagnetic propagation.

5. The accompanying Engineering Statement is true and correct to the best of my information, knowledge, and belief.

This the 14 March, 2000

Ross R. Sorci
Assistant Vice President
IITRI Center for Electromagnetic Science

FURTHER COMMENTS RELATED TO PROPOSED IMPROVEMENTS TO THE ILLR PREDICTION MODEL, ET DOCKET NO. 00-11

14 MARCH 2000

Prepared By:

Ross R. Sorci
Paul A. Petsu

of

IIT RESEARCH INSTITUTE
CENTER FOR ELECTROMAGNETIC SCIENCE
8100 CORPORATE DRIVE
LANHAM, MD 20785-2231

FURTHER COMMENTS RELATED TO PROPOSED IMPROVEMENTS TO THE ILLR PREDICTION MODEL, ET DOCKET NO. 00-11

BACKGROUND

The FCC has released a Notice of Proposed Rule Making (NPRM)[1] prescribing a point-to-point predictive computer model for determining the ability of individual locations to receive an over-the-air television broadcast signal. In its Report and Order in CS Docket No. 98-201, the Commission endorsed the use of a specific model for the prediction of signal strength at individual locations. This model was called the Individual Location Longley-Rice (ILLR) model by the Commission, and is a version of Longley-Rice 1.2.2. Based on a earlier proceeding, the Commission found that vegetation and buildings affect signal intensity at individual locations; however, it also found that there was no standard means of including such information in the ILLR that had been accepted by the technical and scientific community.

The Commission therefore stated that land use and land cover information will be included in the ILLR when an appropriate method for using such information has been developed and accepted. In the NPRM associated with ET Docket 00-11, the FCC proposes to improve the ILLR model by adding clutter loss parameters.

The NPRM for ET Docket 00-11 was released for consideration by the FCC on January 20, 2000, and comments from 13 organizations were received by the Commission.

APPROACH

After the cutoff date for filing comments, IITRI accessed the FCC Electronic Comment Filing System (ECFS) and obtained the comments that have been filed pertaining to ET Docket 00-11. The comments were reviewed and, based on the cited materials and our engineering experience

[1] FCC Notice of Proposed Rule Making, In the Matter of Establishment of an Improved Model for Predicting the Broadcast Television Field Strength Received at Individual Locations, ET Docket No. 00-11, January 20, 2000.

and judgement, IITRI provides further comments on the following technical areas identified in the various comments filed before the Commission.

1. Revision of the Grade B Criteria

2. Use of Clutter Loss Values for All Fresnel Zone Clearance Situations

3. Modification of ILLR to Compute Fresnel Zone Clearance and Compute Associated Loss

4. The Consideration of "Ghosting" and Multipath in ILLR

5. Creation of Additional LULC Categories Based on Building Height, Spacing and Density

6. Use of the TASO Database to Determine Clutter Loss Values

7. The Implementation of Clutter Loss into ILLR with Values Set to 0 on an Interim Basis While Additional Testing and Analysis is Conducted to Select Appropriate Values

8. Application of Waiver Test Results to Neighboring Residences

9. Utilization of Longley Urban Factor (UF) Equation to Assign Clutter Loss Values

10. Consideration of Man-Made Noise and Interference in ILLR

11. RadioSoft Contention that Rubinstein Clutter Loss Values Are Acceptable Due to Antenna Height, Polarization, and Fresnel Zone Factors "Cancelling" Out

12. Examination of Longley UF with Appropriate Transmitter and Receiver Antenna Height Corrections As the Basis for an ILLR Correction Factor

1.) Revision of the Grade B Criteria

A revision of the Grade B service criteria was recommended by the National Rural Telecommunications Cooperative (NRTC).[2] NRTC claims that any improvements to ILLR will have no effect unless the current Grade B signal intensity standard is also modified. The argument also goes on to state that acceptable quality levels for a television picture have allegedly changed in the past 50 years with the advancement of new technologies and heightened consumer expectations.

As an initial matter, modifications to the Grade B signal intensity standard itself are not in issue in this proceeding which is solely concerned with methods that would potentially improve the ability to predict field strength at individual locations.

Moreover, during the past 50 years the state of analog television transmitted signal technology has changed very little. The NTSC standard has not changed, and the signal being provided to consumers is essentially unchanged. The state of technology for consumer receivers and installation practice, however, has improved markedly. The receiver noise floor of current technology receivers is as much as 6 dB better that that found in tube receivers of the 1950s, antenna gain is improved, and transmission line impedance matching has improved due to the use of coaxial cable. The impact of these on the receive system has had the effect of actually increasing the effective signal-to-noise (S/N) at a receiver, providing for a better picture. A technical argument can be made that the Grade B standard could actually be lowered to account for these system improvements or that the picture quality associated with Grade B is better.

Indeed, the Grade B criteria have been reviewed by the Commission several times since it was instituted, and the criteria has withstood the test of time and technology. Reviews

[2] Comments of the National Rural Telecommunications Cooperative, In the Matter of Establishment of an Improved Model Predicting the Broadcast Television Field Strength Received at Individual Locations, ET Docket No. 00-11, February 22, 2000, pp 8-9.

conducted in 1975 by the Commission[3] and later by the UHF Comparability Task Force[4] concluded that there was data to support a reduction in the Grade B standard, although the Commission did not act to do so in either case. More recently, as part of the DTV proceedings, the Commission gave the Grade B standard a vote of confidence by deciding to premise DTV service areas on a replication of existing NTSC Grade B service areas.[5] This reaffirmation demonstrated that the Grade B service criteria are adequate, and no change is deemed necessary by the Commission. Finally, in last year's SHVA proceeding, the Commission again reaffirmed the current Grade B values.

It is arguable that consumer expectations are higher today than 50 years ago if *like* technology systems are compared. Today, many commonly available and premium services are available to provide television programming. Cable, digital cable, digital direct broadcast satellite television (DBS), and analog (C-band) satellite services are available. Of these, a case can be made that the service provided by analog cable and analog satellite is actually inferior to broadcast television in many cases due to implementation, weather, service outage, and installation issues. Digital cable and DBS services can provide improved picture quality; however, they are considered premium services and carry a higher cost of acquiring the suitable equipment, a higher installation cost, and monthly and pay-per-view service fees. Certainly consumer expectations are higher for these higher priced and widely glorified and advertised services than for broadcast television. For these reasons, any comparison of digital DBS service to analog broadcast television is not appropriate and does not serve the consumer in an honest fashion; digital DBS service can only appropriately be compared to DTV service.

---

[3] Television and FM Field Strength Curves, Report and Order, FCC 75-636.

[4] Geisler et al., Comparability for UHF Television: Final Report (Office of Plans and Policy), September 1980.

[5] Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service, Sixth Report and Order, FCC 97-115.

2.) Use of Clutter Loss Values for All Fresnel Zone Clearance Situations

Several responses to the NPRM (DirectTV, EchoStar, CTI) indicated that clutter loss be implemented, not just for unobstructed paths (Fresnel Zone clearance greater than 0.6), but also for paths where Fresnel Zone (FZ) penetration occurs.

It is theoretically correct to implement clutter loss this way, since clutter loss can occur at the receiver for propagation paths that occur over rough terrain. A problem arises, however, if the Rubinstein values are implemented, as proposed, for the ILLR prediction model.

Rubinstein obtained clutter loss, effectively, by subtracting propagation path attenuation, predicted with the Okumura model, from measured path losses. Measurements taken using a mobile unit with a 3m receive antenna will include obstructed paths for most cases. For these, some of the measured loss will be due to FZ penetration along the path. In the proposed ILLR implementation, Longley-Rice predictions of path loss would be modified by adding the Rubinstein clutter loss. But the Longley-Rice model accounts for attenuation for cases when the path is obstructed. If the Rubinstein clutter loss is added to the Longley-Rice loss for such paths, the loss due to FZ penetration will be accounted for multiple times. This policy does not meet the objective of improving the model accuracy as required by SHVIA.

3.) Modification of ILLR to Compute Fresnel Zone Clearance and Compute Associated Loss

In the response submitted by DirecTV, the recommendation is made to modify the ILLR model to include the prediction of loss for paths in which Fresnel zone penetration has occurred. Currently, the Longley-Rice point-to-point prediction model does not provide for the increase in attenuation that would be expected as an obstacle penetrates the first Fresnel zone prior to the obstacle penetrating the central ray between the transmit and receive antennas.[6] In other words, the model assumes line-of-sight (LOS) propagation until an obstacle actually penetrates the central ray (the Fresnel zone clearance is 0), and then switches to a diffraction mode to compute the loss. The range of Fresnel zone clearances between 0 to 1 are apparently treated as LOS.

In their comments, DirecTV does not present a methodology for modifying ILLR to compute the Fresnel zone clearance and assign loss values, nor does it state what the losses should be, or a methodology for determining them. In addition, DirecTV's proposal does not address the basic problem of the proposed ILLR modification to include clutter loss.

With respect to modifying ILLR to include clutter loss, this proposal will not do that, however, it does illustrate a potential new model that could be developed. This tool would allow the modification of the terrain elevation data by adding foliage and buildings and then allow the model to handle clutter as a diffraction mode as models such as Longley-Rice were designed to do, rather than as a add-on or "fudge factor." This would require a very good database of clutter sources, location, size, and height similar to terrain elevation data, or a new terrain elevation database that includes clutter sources. In this way, the consideration of clutter would be site specific, and more accurate than a generalized add-on. At this time, however, such a detailed database does not exist. It is therefore premature to attempt to develop this later generation of ILLR model at this time.

4.) The Consideration of "Ghosting" and Multipath in ILLR

In its comments to the Commission, EchoStar stated that it believes it may be possible to integrate impairment measures into the ILLR model by first establishing an equivalence between "ghosting" (multipath) impairment and signal strength loss, and second, by associating "ghosting" impairment with a set of LULC categories.[7] Biby also raises the

---

[6] Coverage Prediction for the Mobile Radio Systems Operating in the 800/900 MHz Frequency Range, IEEE Transactions on Vehicular Technology, Vol. 37, No 1, February 1988.

[7] Comments of EchoStar Satellite Corporation, In the Matter of Establishment of an Improved Model Predicting the Broadcast Television Field Strength Received at Individual Locations, ET Docket No. 00-11, February 22, 2000, p 5.

issue of "ghosting" and provides an approach for predicting the potential for multipath reception at a given residence.[8]

As an initial matter, "ghosting" has nothing to do with predicting whether a residence receives a signal of Grade B intensity and has no place in the ILLR model. "Ghosting" resulting from multipath interference is a highly localized and individual location specific effect, and it has no direct relation with the signal intensity of a broadcast television station. This proceeding is about improving methods to predict field strength, not the unrelated matter of determining the potential effects of "ghosting."

EchoStar proposes to model the likely occurrence of "ghosting" amplitude and time delay and then establish a correspondence between "ghosting" impairment and the equivalent desired signal intensity loss based on the effect each has on picture quality.

For the sake of argument, while it is possible to measure multipath signal levels and time delays and relate them to a ghosting image on a television receiver, to model them in a dynamic environment of individual receivers will be next to impossible. Multipath propagation to a specific location is highly individual in its sensitivity to small changes in numerous variables, many of which are additive. These variables include terrain; weather (rain, snow); receiving antenna height; antenna location; antenna discrimination (pointing angle); local obstacle locations, size, and geometry; reflection coefficient of potential reflectors; time of year for areas with deciduous trees; wind; and even moving vehicles and aircraft. In addition, even movement of the transmitting antenna in the wind will affect the phase of the desired and interfering signals. To keep track of even a subset of these variables for every target residence and model the unlimited number of potential multipath reflectors and the reflection coefficients associated with them accurately is an insurmountable task with current technological capabilities. In addition, EchoStar and Biby

---

[8] Comments of Richard L. Biby, P.E., In the Matter of Establishment of an Improved Model Predicting the Broadcast Television Field Strength Received at Individual Locations, ET Docket No. 00-11, February 22, 2000, pp 13-14.

do not even make mention of determining the reflection coefficients of the unlimited number of potential multipath reflectors in the environment.

Relating the variables utilized in any multipath prediction model to the current LULC database will not work. The size of the LULC grids is approximately 200 m^2 in urban areas and 400 m^2 in rural areas. If a potential multipath reflector could be located anywhere within this large area, it would be impossible to accurately predict the likelihood of a ghosting problem at any particular location or residence with any confidence whatsoever.

Lastly, as pointed out by Biby, technical solutions also exist to eliminate the impact of "ghosting" and multipath.[9] Ghost cancelling integrated circuits are available from at least one manufacturer that can be used to eliminate the impact of "ghosting" on picture quality.[10] These ghost cancellers utilize adaptive equalizers to eliminate the effects of time shifted signals. The fact that this technology is not currently used in the industry may be that consumers do not view ghosting as a significant problem or have successfully solved the problem. Hence, receiver manufacturers have not offered it (even as an option) due to lack of need.

The methodology required to incorporate the prediction of "ghosting" in ILLR will not produce meaningful results and will unnecessarily complicate the model and increase the data requirements to run it. Moreover, as stated earlier, "ghosting" really has nothing to do Grade B signal intensity and has no place in the ILLR model.

If a correspondence between "ghosting" impairment and the equivalent desired signal intensity loss based on the effect each has on picture quality makes sense to incorporate into ILLR, then an equivalent correspondence between DBS availability effects such as rain outage, sun transit outage and the like and Grade B be could also be formulated in the same manner. This illustrates the artificial nature of this type of analysis.

---

[9] Reference 8, p 15.

If "ghosting" were a major problem, the implementation of existing technical solutions would minimize the impact, and television receiver manufacturers would offer it to consumers.

5.) Creation of Additional LULC Categories Based on Building Height, Spacing and Density

The proposed clutter loss modification to the ILLR is based on 10 general land use categories derived from the USGS LULC categories. These categories represent some variations in land cover characteristics but lack any serious resolution regarding the height and density of possible obstructions. Two categories (mixed urban/buildings and residential) are the only discriminants of building height and density. This is not sufficient for representing the wide range of heights and building densities that are possible in these categories of areas.

The primary problem, however, is not the number of categories per se but the availability of measured data. While some data are available, it is insufficient for ILLR application. To adequately implement a clutter loss model in the ILLR it is necessary to first perform the measurements needed to obtain accurate, representative data intended specifically for this application. That data would need to be collected based not only on building height and density, but also in areas that correlate with the designated land use categories. Ultimately, it is doubtful that data with sufficient resolution will ever be available for purposes of ILLR applications.

6.) Use of TASO Database to Determine Clutter Loss Values

The Association of Federal Communications Consulting Engineers (AFCCE) does not support the use of Rubinstein's results as the basis for clutter loss values and recommends

[10] Oren Semiconductor, 2620 Augustine Drive, Suite 238, Santa Clara, CA 95054, (www.oren.com).

that the Commission evaluate a more complete and relevant database for this purpose.[11] The recommended TASO database, maintained on the Commission's website, contains radio field strength measurements and associated location, EIRP, antenna, and path information for 185 VHF data sets and 77 UHF data sets in 15 cities in the United States (See Table 1). Each data set consists of a radial from the transmitting antenna with measurement locations along the radial. This data is based on field strength surveys conducted by A. D. Ring & Associates for the Association of Maximum Service Telecasters, Inc. during the period 1954-1962. A sample of the TASO data is provided as Table 2.

The database also contains a graph comparing the measurement data versus a Longley-Rice prediction for each data set (radial). Theoretically, this is a much better situation than utilizing Okumura as the basis for analysis as Rubinstein did. The difference between the measured field strength values and the Longley Rice predictions represents a correction factor, of which clutter is a component.

While the TASO database represents a much better source of measured data that is specific to television broadcasting than the Rubinstein measurements, it has several shortcomings that materially limit its use as the final arbiter of clutter loss values. First, the data was collected for 15 cities in the United States, mostly in the northeastern and mid-Atlantic areas. A comprehensive data set for clutter loss purposes would include data from all of the diverse geographical and vegetation areas in the country. Data should be collected in the desert southwest, Texas, the Rocky Mountain states, the Northwest, Florida, and the Plains states to be truly representative of the different clutter conditions that may be found. Another potential issue is the age of the TASO data. Some of the measurements are more than 45 years old, and a considerable amount of development has taken place in the cities that were surveyed. Even if the data are paired up with the equally aged USGS LULC data, it would still represent an old database.

---

[11] Comments of AFCCE, In the Matter of Establishment of an Improved Model Predicting the Broadcast Television Field Strength Received at Individual Locations, ET Docket No. 00-11, pp 2-3.

TABLE 1

TASO DATABASE MEASUREMENT CITIES

Baltimore, MD	Milwaukee, WI
Baton Rouge, LA	Nashville, TN
Boston, MA	New York, NY
Buffalo, NY	Philadelphia, PA
Columbia, SC	Springfield, MA
Detroit, MI	St. Louis, MO
Fresno, CA	Wilkes Barre, PA
Madison, WI	

TABLE 2

SAMPLE TASO MEASUREMENT DATA

Call Sign	Data Source	Latitude (seconds)	Longitude (seconds)	Freq (MHz)	City	State	ERP (dBK)	TX Elev. (m)	Ant Height (AGL)	Ant Height (HAAT)	Azimuth	Date	Time	Distance (km)	RX Elev (m)	RX ant (m)	Median (dBu)
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	9/8/62	1345	14.6	-999	9	61.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	3/2/62	1600	15.9	-999	9	59.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	9/8/62	1425	19.3	-999	9	63.9
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	3/2/62	1620	19.3	-999	9	64.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	3/2/62	1640	22.4	-999	9	64.9
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	9/8/62	1500	22.4	-999	9	65.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	3/2/62	1700	25.9	-999	9	57.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	9/8/62	1615	25.9	-999	9	55.9
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	9/8/62	1640	29	-999	9	59.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	13/03/62	1524	29	-999	9	61.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	10/8/62	1340	32.3	-999	9	54.9
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	13/03/62	1557	32.3	-999	9	58.9
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	10/8/62	1407	35.2	-999	9	61.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	13/03/62	1609	35.2	-999	9	60.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	10/8/62	1525	38.7	-999	9	50.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	13/03/62	1630	38.7	-999	9	53.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	10/8/62	1555	41.5	-999	9	56.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	13/03/62	1651	41.5	-999	9	56.9
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	12/8/62	1045	44.3	-999	9	44.9
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	13/03/62	1715	44.3	-999	9	42.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	12/8/62	1133	48.7	-999	9	48.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	14/03/62	853	48.7	-999	9	48.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	12/8/62	1240	51.5	-999	9	45.9
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	14/03/62	935	51.5	-999	9	44.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	12/8/62	1325	54.7	-999	9	48.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	14/03/62	1000	54.7	-999	9	46.4
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	12/8/62	1600	57.4	-999	9	36.9
WCBS	FCC	146694	266350	55.2	NEW YORK	NY	16.1	15	393	396	0	14/03/62	1020	57.4	-999	9	36.4

In addition, the fact that the database contains only a graph with the Longley-Rice predictions, rather than the raw individual predictions severely limits the database's usefulness for tweaking any correction factors that may be applied to the ILLR implementation. It is recommended that the methodology used to collect the TASO data be reviewed and updated as necessary for use in a modern collection effort specifically for the purpose of refining the ILLR model.

7.) The Implementation of Clutter Loss into ILLR with Values Set to 0 on an Interim Basis While Additional Testing and Analysis Is Conducted to Select Appropriate Values

The proposed modification to the ILLR model to account for clutter loss using the Rubinstein data is inadequate. The data are flawed since they were not collected in areas that adequately represent the 10 ILLR clutter categories, the receive and transmit antenna heights did not represent those encountered in TV broadcast, it appears that data obtained at different transmitter heights were indiscriminately added together, and measurements were taken for vertical polarization vis-à-vis horizontal polarization. An additional problem is introduced by the use of the Okumura model in determining the clutter loss values from the measurements.

The ILLR model has been shown through testing to be a reliable predictor of Grade B service. The addition of clutter losses based on the Rubinstein data will not improve the accuracy of the model for this purpose. If an interim model is deemed to be necessary, then implementing the mechanics of the modification using clutter losses of zero would be more accurate than using the Rubintsein data. This interim model could be used until a measurement program is developed and performed to provide the required clutter loss data.

However, it remains far from clear that an approach in which clutter loss values are associated with LULC categories will ever improve the overall accuracy of the ILLR model.

It is highly doubtful that topographic data of sufficiently fine resolution will ever become available for ILLR purposes.

8.) Application of Waiver Test Results to Neighboring Residences

The test results obtained at a particular location will be dependent on a set of variables that are specific to that particular location and antenna installation. In a dense urban area dominated by homogenous townhouses/rowhouses or new housing developments on minimal sized lots or in areas that have been clear cut of trees it may be possible to extrapolate test results to neighboring residences as recommended by DirecTV.[12] This is also not a very interesting situation because these areas are likely to be well above Grade B signal levels.

In many suburban or rural areas, the proposed application of test data to neighboring residences will not be appropriate in most cases. These areas are likely to have residences with larger lot sizes, have more varied foliage, and be less homogeneous in nature. At any particular location the antenna installation parameters such as antenna position and height above ground and antenna pointing angles will vary, the presence of local obstructions and trees may be different, and the sight angles to these obstructions can be significantly different from one residence to the next. A television broadcaster may wish to agree to utilize neighboring residence test data to reduce the cost or burden of the waiver and testing processes, but broadcasters should not be required to follow this procedure or be pressured by the Commission to do so.

[12] Comments of DirecTV, In the Matter of Establishment of an Improved Model Predicting the Broadcast Television Field Strength Received at Individual Locations, ET Docket No. 00-11, February 22, 2000, p 10.

9.) Utilization of Longley Urban Factor (UF) Equation to Assign Clutter Loss Values

Biby has proposed an alternative method of estimating clutter loss for ILLR modifications. His proposal is basically a minor modification of the urban factor proposed by Longley.[13] The Longley urban factor was developed based on predictions obtained with the Longley-Rice propagation model and measurements taken by Okumura for an urban area. This approach has some validity for predicting clutter loss, but it also has some of the limitations of the Rubinstein data when applied to Grade B service determination.

The biggest problem with Biby's proposal, however, is that he fails to account for differences in the transmit and receive antenna heights. These differences substantially affect the urban factor correction that would be returned by Longley's equation.

10.) Consideration of Man-Made Noise and Interference in ILLR

Biby, in his response to the NPRM, also addresses the subject of man-made noise and provides a summary of published data. The data appear to show that man-made noise can be on the order of 13 – 30 dB above kT_0B for urban (business) areas at frequencies corresponding to channels 2 and 13. Sources of man-made noise include ignition systems, high-voltage transmission lines, arc welders, and most electrical equipment. Noise is an important consideration in TV broadcast, as it is in all radio systems, and it can be a limiting performance factor. The same can be said for interference. Rubinstein also presents measured noise data at 162 MHz for the same conditions as his clutter loss. Biby recommends that the FCC predictive model should be modified to consider urban noise.

Both noise and interference can be important considerations when evaluating the performance of TV reception, and methods for addressing them are provided in OET-69. However, the issue being addressed in this NPRM is Grade B service field strength—which

[13] Longley, Anita, G., Radio Propagation In Urban Areas, 28th IEEE Vehicular Conference, Denver, CO, March 1978, pp 503-511.

is entirely independent of noise and interference. Consideration of noise and interference is not relevant to the determination of field strength and should not be added to the consideration of modifications to the ILLR to include clutter loss.

11.) RadioSoft Contention that Rubinstein Clutter Loss Values Are Acceptable Due to Antenna Height, Polarization, and Fresnel Zone Factors "Cancelling" Out

In the response provided by RadioSoft,[14] the assertion is made that error introduced in the Rubinstein clutter data by using a 3m antenna and vertical polarization tend to cancel. There are other factors, related to polarization, that affect the derived clutter loss values. These have to do with the obstructions that give rise to the clutter loss. In urban areas the surrounding buildings are predominantly vertical. Building reflection coefficients for vertically-polarized waves exceed those for horizontally-polarized waves; therefore, the measured clutter will be greater than for horizontally-polarized TV signals. As a result, TV antennas located on the lower rooftops of buildings surrounded by higher ones may be subjected to less clutter than measured by Rubinstein. Also, in residential areas, where tall trees surround the houses, the absorption for vertically-polarized waves would exceed that for horizontally-polarized waves and, again, the Rubinstein clutter value would be excessive for the horizontally-polarized waves.

As shown in our initial comments, the effects of raising the receive antenna height, polarization, and Rubinstein's incorrect assumption that his sites possessed full Fresnel zone clearance all serve to *reduce* the clutter loss values found by Rubinstein. There is no warrant for the assertion that they "cancel" out.

---

[14] Comments of RadioSoft, In the Matter of Establishment of an Improved Model Predicting the Broadcast Television Field Strength Received at Individual Locations, ET Docket No. 00-11, February 22, 2000, p 1.

12.) Examination of Longley UF with Appropriate Transmitter and Receiver Antenna Height Corrections As the Basis for an ILLR Correction Factor

An effort was made to formulate a correction factor that could be used with ILLR based on the Longley "Urban Factor" (UF) formula with appropriate transmitter and receiver antenna height corrections. This correction factor would include the effects of clutter, Fresnel zone clearance, and other propagation effects, but it was assumed that clutter loss would be the primary effect for the paths of interest. In her paper Radio Propagation in Urban Areas, Longley observed that the Longley-Rice computer prediction model, with the urban factor added, should adequately predict the median attenuation for moderately large cities. In quite hilly terrain, Longley found that it was not necessary to add an urban factor at all, concluding that the "urban factor" is also a function of terrain irregularity and decreases as the terrain becomes more irregular.[15]

The Longley UF with transmitter and receiver antenna height corrections ("UFC") was presented in earlier comments as a means of correcting for the land mobile character of the original formula, which was based on a receiver antenna height of 3m and transmitter height of 200m.[16,17] The revised "urban factor" has the generalized form shown in Equation 1, where $a(h_t)$, and $b(h_r)$ were derived from Hata's equations and represent corrections for a change in transmitter and receiver antenna height from 200m and 3m respectively. This formulation served as the basis for an effort to evaluate if a refined correction factor could be developed that is applicable to broadcast television Grade B coverage prediction use.

$$UFC = 16.5 + 15 \log(f/100) - 0.12d - a(h_t) - b(h_r) \qquad \text{Eq. 1}$$

where f = frequency in MHz

d = distance in km

[15] Longley, A. G., Radio Propagation in Urban Areas, 28th IEEE Vehicular Technical Conference 503, March 1978.

[16] Joint Comments of the ABC, CBS, Fox, and NBC Television Network Affiliate Associations, In the Matter of Establishment of an Improved Model Predicting the Broadcast Television Field Strength Received at Individual Locations, ET Docket No. 00-11, February 22, 2000, pp 27-28.

[17] Engineering Statement of IIT Research Institute, Evaluation and Comments Related to Proposed Improvements to the ILLR Prediction Model, ET Docket No. 00-11, February 21, 2000.

The methodology used to evaluate potential correction factors was based on comparing measured television field strength values for 8 VHF and UHF channels in the United States with predicted field strength values produced by ILLR for the same locations and developing a correction factor for ILLR that adequately minimized the difference between the predicted and measured field strength values at the same locations.

The measurement database that was used consisted of approximately 1000 data points of television specific field strengths taken using a receiver antenna height of 30 feet. More than 600 of the data points were measured and placed in evidence in the matter of CBS v. PrimeTime 24.[18] In addition, 199 measurements of field strength were also collected for Channel 6 and as well as 199 measurements for Channel 53 in connection with the comparison of NTSC and DTV performance as part of field testing of the "Grand Alliance" DTV system. These measurements provide data for television channels 3, 4, 6, 7, 11, 13, and 53 in Pittsburgh, Miami, Durham, Baltimore, and Charlotte. No correction factors or manipulation of the measured data was required for the purpose of this analysis.

ILLR predictions were made for each of the approximately 1000 site measurements. The differences between the measured and predicted field strength values were evaluated using the Longley UF and UFC to try to develop a generalized correction formula that could be applied to ILLR to estimate the effects of clutter. This process was conducted on the data for individual stations in each of three general frequency bands: low VHF, high VHF, and UHF.

A regression analysis was applied to the measured and predicted values versus distance data for the 3 low VHF, 3 high VHF, and 2 UHF channels to facilitate the analysis. The first test case that was evaluated consisted of applying the UFC factor as described above to the ILLR predicted values, and then comparing the results to the measured data. For the purposes of the analysis, the complete set of data for each frequency band was examined and certain outliers

---

[18] CBS Inc. v. PrimeTime 24 Joint Venture, No. 96-3550-CIV Nesbitt (S.D. Fla.).

were removed from consideration if the difference between the measured signal intensity and the predicted signal intensity was more than one standard deviation. The UFC-modified predicted and test measurement values were then compared for the channels in the specified low VHF, high VHF, and UHF frequency ranges. The difference between the measured field strength values and the UFC adjusted predictions was then examined and plotted. The best least squares fit to the difference was determined for each channel in each band. This regression process was repeated for the 3 resulting curves in each band (2 for UHF) to obtain a single expression that represents the correction to be added to the UFC. Curves for the three bands are shown as Figures 1 through 3 (attached hereto). The correction formulas for each band are presented in Table 3. Each formula represents a factor that could be added to the UFC as a function of transmitter antenna height and distance from the transmitter.

The second test case consisted of the Longley UF without the transmitter and receiver antenna height correction factors. The same process was used where the difference between the measured values and the UF-adjusted predictions were analyzed, and the best fit curve representing the correction for each band to be added to the UF was determined. The correction factor curves for the low VHF, high VHF and UHF bands are presented as Figures 4 through 6 respectively (attached hereto), and the generalized formulas are provided in Table 4.

Upon examination of the resulting functions, it was determined that they represented a poor fit to the data. This is due mainly to limitations in the measured data set and the correction factor formulation. Recommendations for further effort in this direction include expanding the size and coverage of the measurement data, evaluating additional variations of the Longley Urban Factor, and evaluating correction factors that are not based on the Longley Urban Factor. Additional measurements should include additional geographical areas and a wider sampling of channels and transmitter antenna heights, particularly at UHF. Some of this data may be obtained by utilizing the TASO database available from the Commission paired with appropriate Longley-Rice prediction runs and by performing additional measurements in various geographical areas and and at various frequencies (channels) that are currently under-represented in the measured data.

TABLE 3
ILLR CORRECTION FACTORS

Longley UF with Antenna Height Corrections (UFC)

Band	*Correction Factor to Be Added to UFC*
Low VHF	$\Delta_{UFC}(h_t,d) = (0.06355\ h_t - 13.0137) + (-0.004412\ h_t + 2.02248)\ d + (0.000070778\ h_t - 0.04041)\ d^2$
High VHF	$\Delta_{UFC}(h_t,d) = (0.070023\ h_t - 22.379) + (-0.003809\ h_t + 2.1419)\ d + (0.00003894\ h_t - 0.02408)\ d^2$
UHF	$\Delta_{UFC}(h_t,d) = (-0.04394\ h_t + 29.4424) + (0.0045676\ h_t - 1.459)\ d + (-0.00008873\ h_t + 0.02397)\ d^2$

TABLE 4
ILLR CORRECTION FACTORS

Longley UF Without Antenna Height Corrections (UF)

Band	*Correction Factor to Be Added to UF*
Low VHF	$\Delta_{UF}(h_t,d) = (0.0014\ h_t - 2.7558) + (-0.0017\ h_t + 0.8938)\ d + (0.00004\ h_t - 0.243)\ d^2$
High VHF	$\Delta_{UF}(h_t,d) = (-0.01214\ h_t + 6.3707) + (-0.002552\ h_t + 1.4649)\ d + (0.000027482\ h_t - 0.01687)\ d^2$
UHF	$\Delta_{UF}(h_t,d) = (-0.03159\ h_t + 6.6142) + (0.001585\ h_t - 0.54503)\ d + (-0.000054225\ h_t + 0.013246)\ d^2$

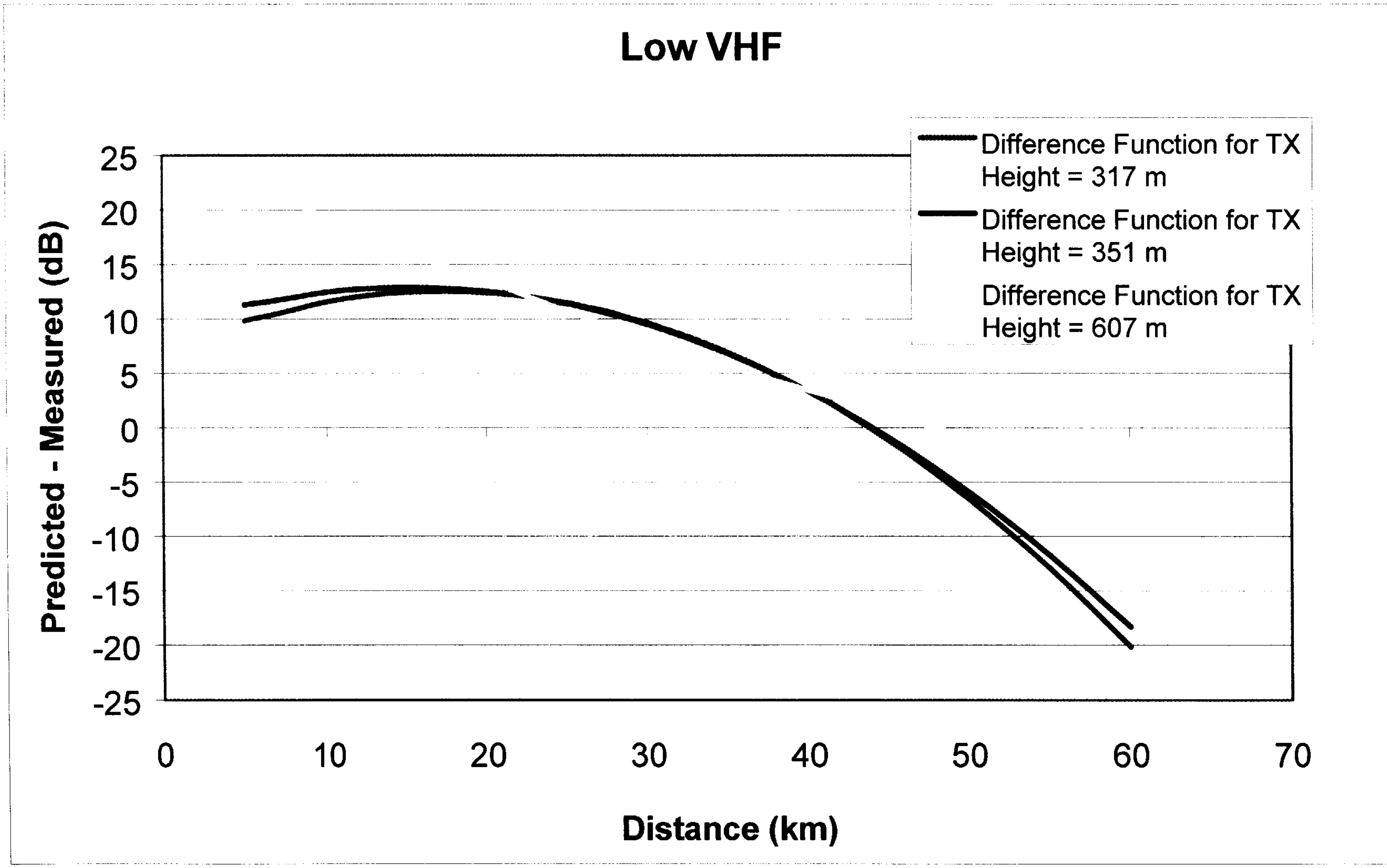

Figure 1. UFC-Based Low VHF Correction Factor Versus Transmitter Antenna Height

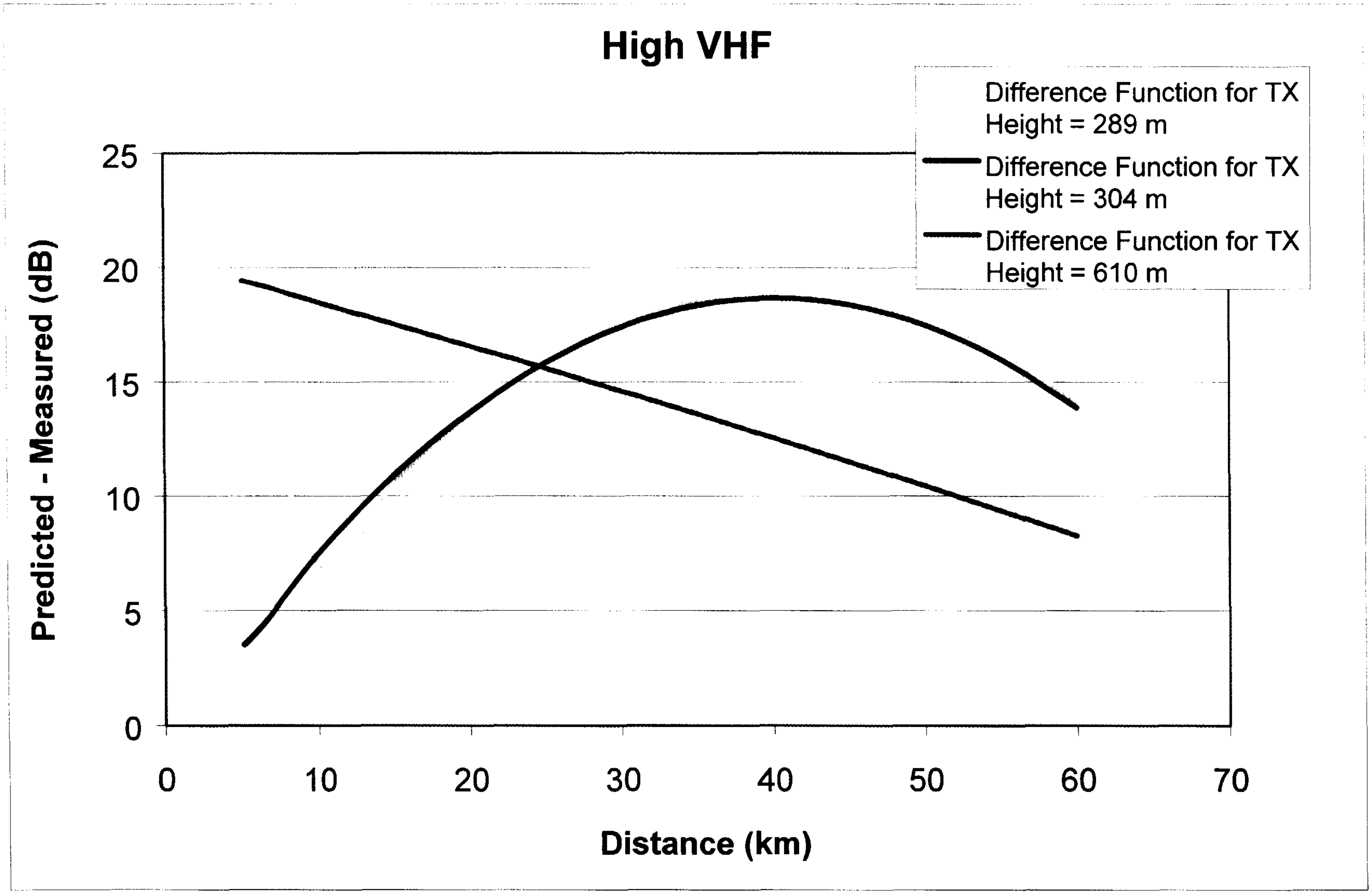

Figure 2. UFC-Based High VHF Correction Factor Versus Transmitter Antenna Height

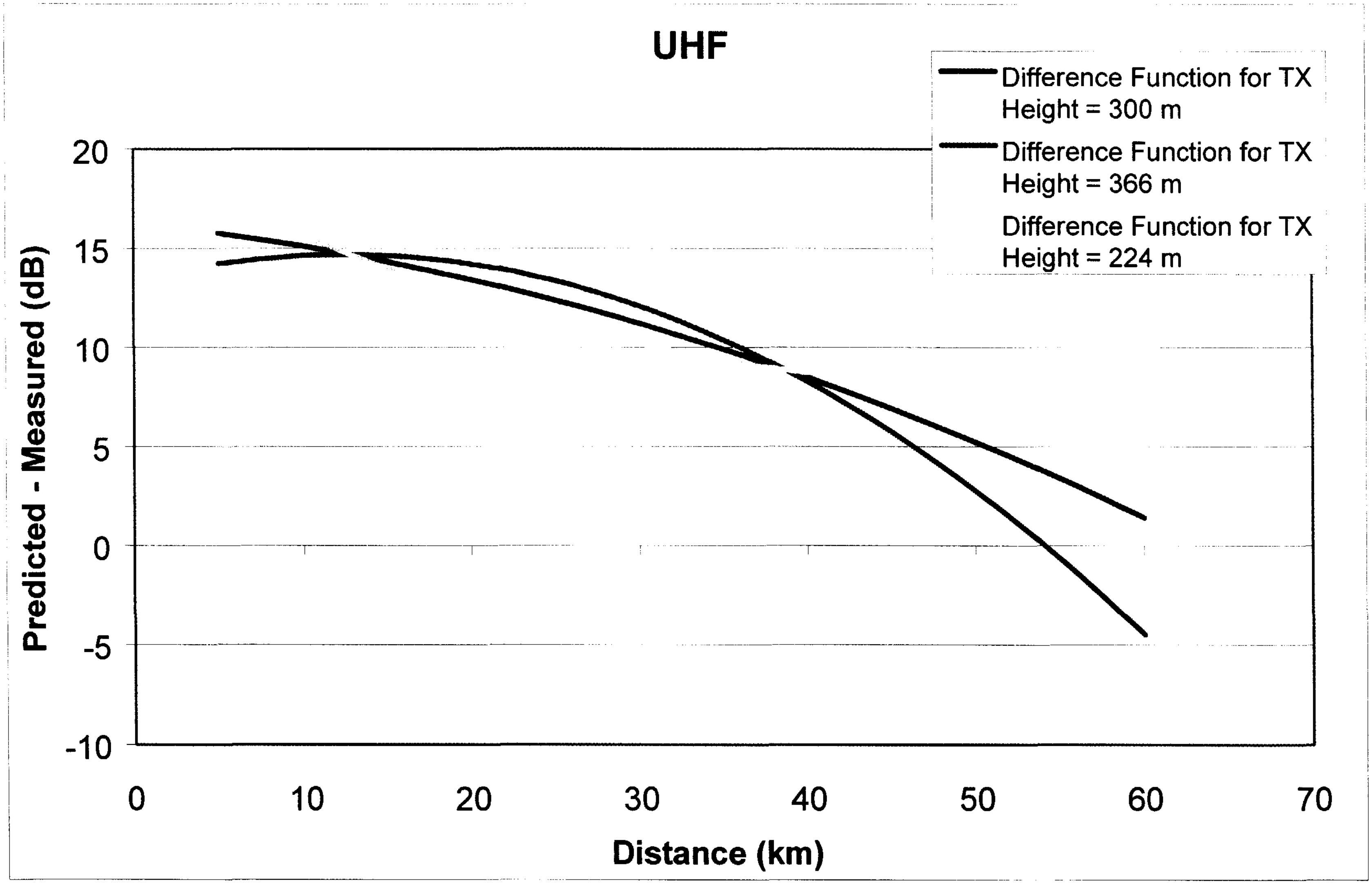

Figure 3. UFC-Based UHF Correction Factor Versus Transmitter Antenna Height

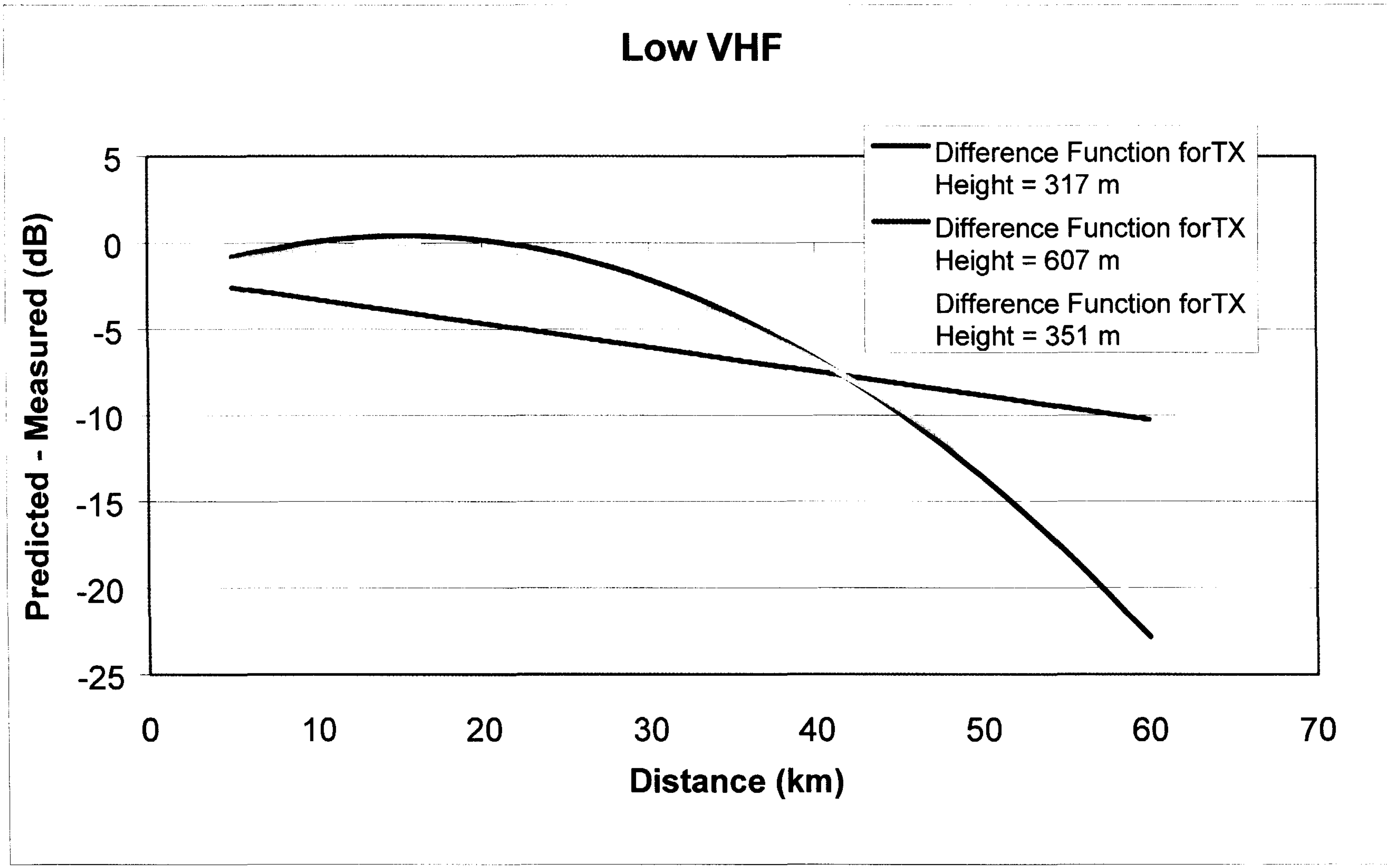

Figure 4. UF-Based Low VHF Correction Factor Versus Transmitter Antenna Height.

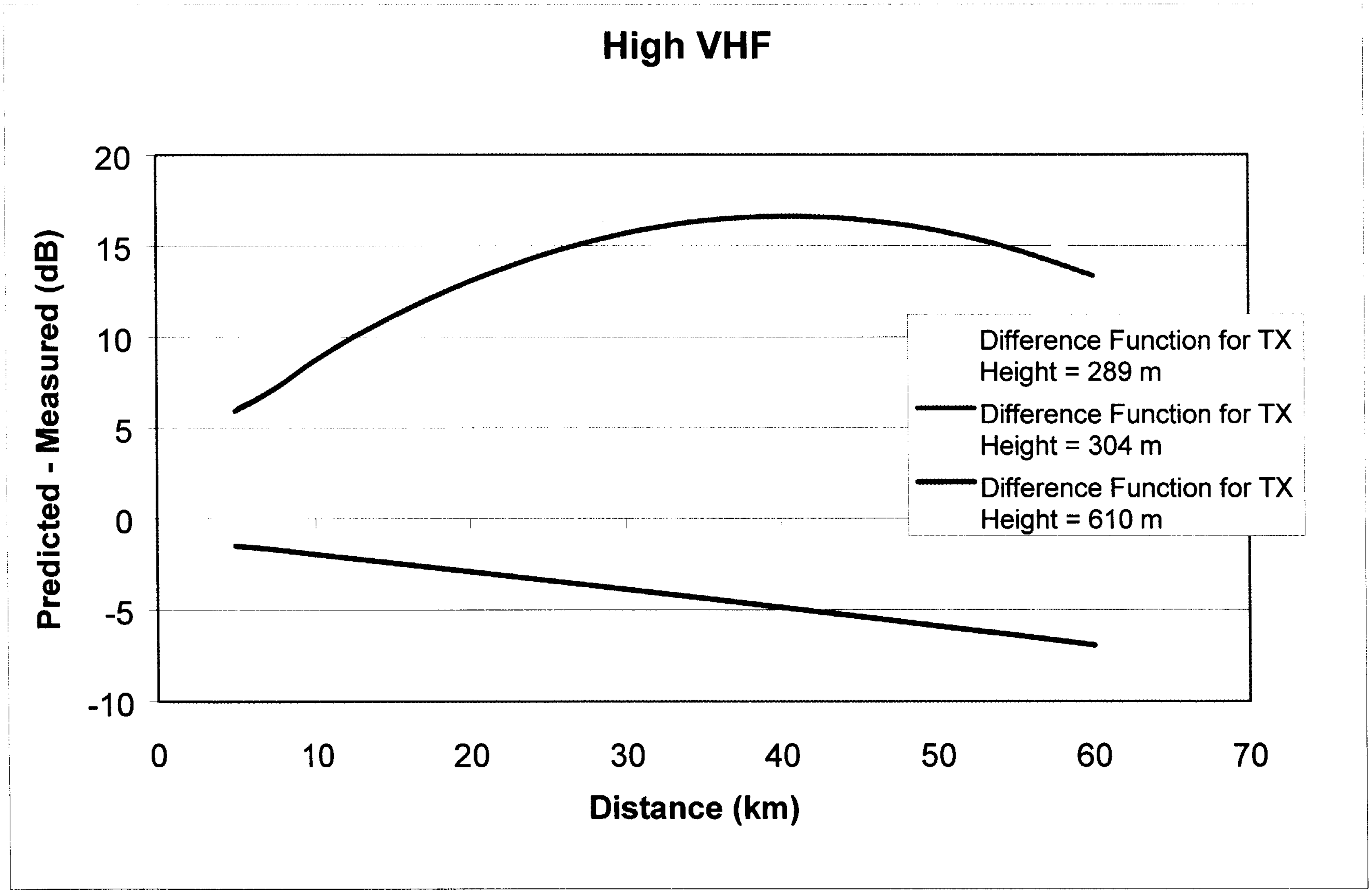

Figure 5. UF-Based High VHF Correction Factor Versus Transmitter Antenna Height.

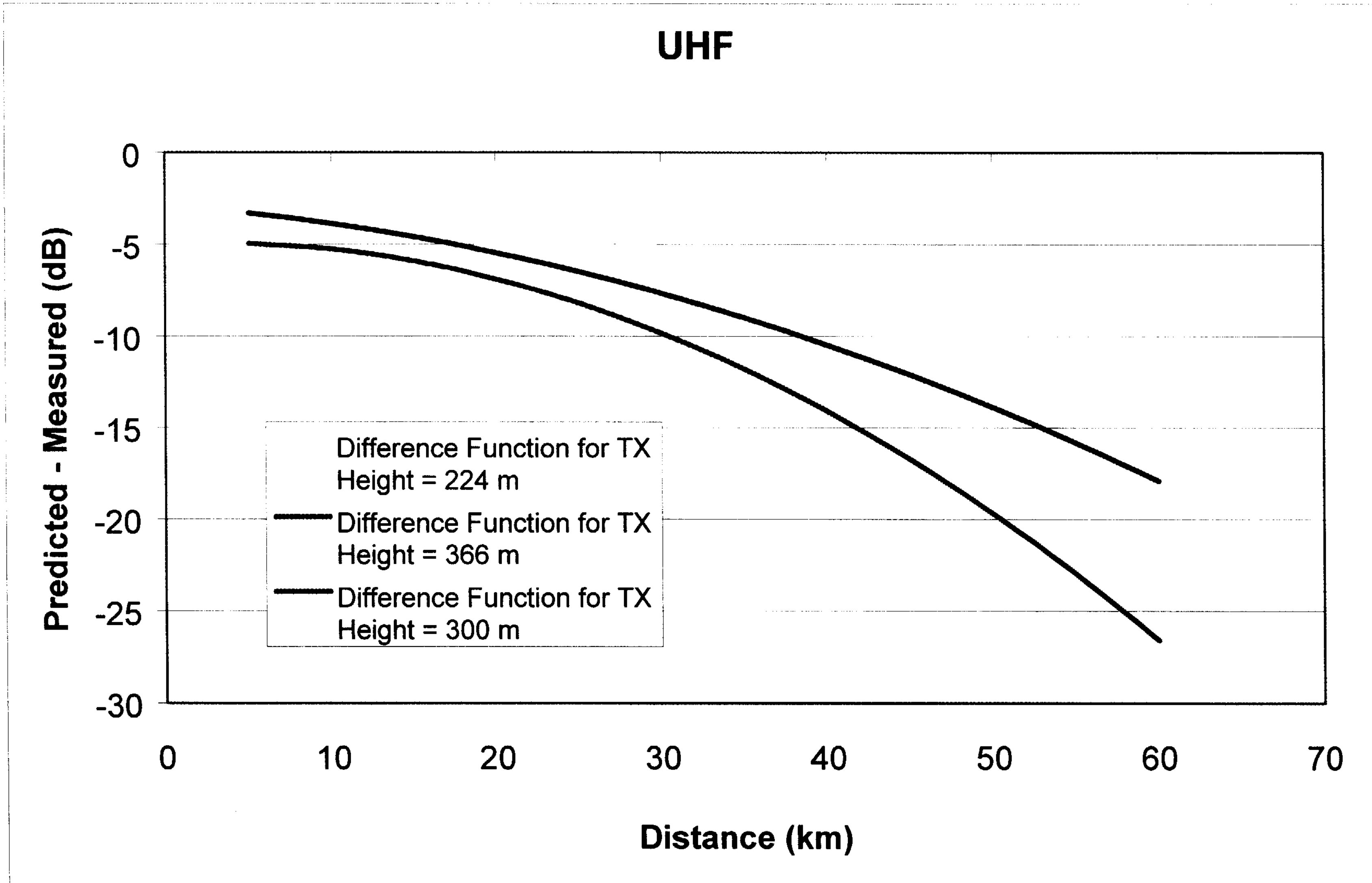

Figure 6. UF-Based UHF Correction Factor Versus Transmitter Antenna Height